Cheat Sheet Anatomy 2 By : Leena Al-Nsour

- CNS ➔ Brian and spinal cord
- PNS ➔ 12 Cranial/ 31 Spinal + associated ganglia
- In Histological preparation ➔ Myelin sheaths are lost leaving round empty spaces.
- Gray matter contains (almost) everything *except MYELINATED axons*.
- Brain parts ➔ Forebrain, midbrain, hindbrain.
- In the brain ➔ outer layer (cortex) in cerebrum and cerebellum is gray matter. Deep regions: white matter.
- Spinal cord occupies 2/3 of the spinal canal. It reaches the lower border of L1/ L2 (***Intervertebral disk between L1-L2***).
- The roots of the sacral and lumbar nerves below the IVD L1-L2 level form a vertical bundle of nerves called ➔ ***Cauda Equina***, and it resembles a horse's tail.
- General Rule: The spinal nerve emerges from the intervertebral Forman of the inferior corresponding vertebra except cervical nerves (8 nerves and 7 vertebrae)
- **Dura Mater:**
  a. Outermost layer + closest to bony canal
  b. Continuous with epineurium of the spinal nerves
  c. Dense irregular CT (hard)
  d. Extend from the level of the foramen magnum to S2 level.
- **Arachnoid Mater:**
  a. Spider's web like
  b. Thin
  c. Made of delicate collagen + some elastic fibers.
- **Pia Mater:**
  a. Tender
  b. Inner most
  c. Bound tightly to the surface of the spinal cord and brain
  d. Thin transparent CT
  e. 2 modifications:
    1. At the end of the spinal cord, **L1-L2**, the pia mater fuses from all directions and descend to form **filum terminale**.
       Filum: thread-like structure
       Terminale: end cord to coccyx.
       Fun: It has a rule in stabilizing the spinal cord.
    2. **Denticulate ligaments** ➔ Attaches spinal cord to the arachnoid mater. It extends from the pia mater to the arachnoid and inner surface of the dura mater.
       Fun: stabilizing the spinal cord inside the vertebral canal.

- Spaces between the meningeal layers: 3 layers
  1. Epidural: Between dura mater and the bony wall of the vertebral canal.
     a. Some anesthetics are injected here. i.e during delivery.
     b. How? By passing a needle from the back until reaching the epidural space.
     c. It's filled with fat ➔ **Potential space** (not empty).

2. Subdural space:
    a. Between Dura and Arachnoid.
    b. Filled with serious fluid that resembles the serum.
    c. Fun: Separates the dura mater from the arachnoid.
3. Subarachnoid:
    a. Between Arachnoid and Pia
    b. <u>Filled with CSF</u>
    c. This space communicates with the ventricles of the brain.
    d. Lumbar Puncture: L3-L4 in adults and Supracristal line in children.

- CSF:
    - <u>*Physiological value*</u>: helps in cushioning and protecting the CNS from minor trauma.
    - It is produced from choroid plexus in the room of the ventricles.
    - It passes from these ventricles of the brain until reaching the 3 apertures of the 4th one.
    - Those apertures open into the subarachnoid space ➔ CSF circulates.
    - <u>Diagnostic value</u>: In cases of aneurysm + hypertension, blood vessels in the subarachnoid space may rupture and cause a hemorrhage➔ we will find blood in the CSF.
      ➔ Sample is taken through **Lumbar puncture**: a needle is carefully inserted into the spinal canal low in the back. Best place/ safe:
      <u>In Adults:</u> **between L3-L4.** Why?. So we won't injure the Spinal cord since it ends at the level of L1-L2.
      <u>In Children:</u> Lowest level of the back ➔ **supracristal line**; from the right iliac crest to the left iliac crest.
- Aperatues (openings) of the 4th ventricle:
    - 2 lateral ones ➔ foramens of Luschka
    - 1 medial ➔ foramen of Megendi
- Herniated Disc/ slipped disc/ ruptured disc
  Each vertebra is formed by a **body**, an **arch** (laminae and pedicles) and **7 vertebral processes** (1 spinous, 2 transverse, 4 articular). Between each 2 vertebrae, we have an intervertebral fibrocartilage "Mingling مزج **hyaline** cartilage and **dense CT**" disc which is formed from:
  1- ***Annulus fibrosus (outer layer):*** annulus; a ring, fibrosus; because it's formed by concentric fibrocartilage laminae.
  2- ***Nucleus pulposus (in the center)***: nucleus; a central core, pulp; any soft, flaccid, juicy tissue (gelatinous), especially when surrounded by harder material.
- The herniation Nucleus pulposus is from a ***Posterolateral direction*** ➔ This herniation will cause a pressure on the spinal nerve that is emerging form the IVF and causes certain symptoms.

Ventral Root	Dorsal Root
1. Efferent fibers 2. Carry impulses to skeletal muscles and glands 3. Their cell bodies are in the anterior gray horn 4. ALWAYS PURE MOTOR fibers going to ***myotomes***.	1. Afferent fibers 2. Carry impulses to the CNS 3. Cell bodies in the posterior gray horn 4. ALWAYS PURE SENSORY coming from ***dermatomes***.
They unit to form ➔ ***Trunk of spinal cord*** *Mixed: Sensory & motor*	
Posterior Ramus 1. MIXED 2. Passes posteriorly around the vertebral column. 3. Supplies the muscles and the skin of the back.	Anterior Ramus 1. MIXED 2. Continues anteriorly 3. Supplies the muscles and the skin over the anterolateral body wall.
In addition to the anterior and posterior rami, spinal nerves give small **meningeal branches.** Supply the meninges.	

- Most muscles are innervated by 2-4 spinal nerves, however, if we trace back the nerve supply of a certain muscle ➔ we'll find **the root value** (1 major spinal nerve) ??
- Most common lumbar disc herniation ➔ IVD L4-L5 OR IVD L5-S1 (95%).

Disc	Root	Percentage	Motor weakness (Myotome)	Sensory changes (Derma-tome)	Reflex affected
L3-L4	L4	3-10%	Knee extension (Quadriceps femoris	Anteriomedial leg (saphenous)	Knee jerk
L4-L5	L5	40-45%	Big toe dorsifelxion (EHL) and TA	Big toe , anteriolateral leg (Common P)	Hamstring jerk
L5-S1	S1	45-50%	Foot planter flextion (Gastrocnemius)	Lateral border of foot (sural)	Ankle jerk

** YOU CAN SKIP ROWS 2+3 below, they were mentioned in the sheet, but I don't think they're important:

NERVE SUPPLY	AREA	Motor	Root	Test
1. *Femoral nerve (branches: saphenous N)*	*Anterior side of the thig/ Anteromedial side of the leg: saphenous N.*	*Quadriceps ➔ extension of the knee*	*L2, L3, **L4***	*Knee Jerk*
2. Obturator nerve	Medial side of the thigh			
3. Sciatic nerve	Posterior side of the thing and supplies the leg			
4. **Tibial nerve,** branch from the Sciatic nerve	**Posterior compartment** of the leg + lateral aspect of the **foot** that is innervated by Sural nerve (branch from Tibial)	**Gastrocnemius** muscle(posterior compartment of the leg)	L4-S3 **S1**	Ankle Jerk
5. **Fibular nerve** (common peroneal) a branch from the Sciatic nerve	anterolateral side of the leg + big toe	**Extensor Hallucis Longus** & **Tibialis anterior**. (found in the anterior compartment of the leg.) Fun ➔ **dorsiflexion**	L4-S3 **L5**	Hamstring Jerk

1. Herniation in IDV L3-L4: Pressed root L4 ➔ affecting femoral nerve ➔ pain associated with related area and motor supply.
- Herniation in the spinal cord causes neuropathy (pain) but not loss of sensation (function) ➔ ***Tactile Allodynia*** ➔ central pain sensitization/ increased neuronal response/ Pain associated with normally non-painful stimulation. / the threshold for pain becomes lower. Inflammation also might cause Allodynia
- TEST: Impaired Knee extension

2. ***Herniation in IDV L4-L5*** ➔ Pressed root L5
- Symptoms mainly associated with Fibular nerve, (No. 5 in the table above).
- TEST ➔ Ask the patient to walk on his **heels**. (dorsiflexion test)

3. Herniation in IVD L5-S1: ➔ Pressed root S1
- Affected nerve ➔ Tibial, No. 4 in the table above.
- TEST ➔ Ask the patient to stand or walk on his **tiptoes**. (plantar flexion test)

Major Symptom of disc herniation ➔ Low back pain.

- Where?
- Low back radiating pain to the gluteal region ➔ back of the thigh and the leg.
- Why?
- After the spinal nerve forms the dorsal and ventral roots, it gives a **meningeal branch** (recurrent branch) that innervates the **dura**, and brings sensation from it.
- Dura is very sensitive to **stretch**.
- The prolapsing disc will exert a pressure on the spinal nerve and on the dura matter ➔ this causes pain
- Notes:
- It's very hard for the patient to pin-point the exact place of pain.
- Because pain is diffused due to overlapping dermatomes (more overlapping in the lower body).
- Many other diseases cause pain in the lower back, however, in case this pain was PROLONGED, it is suggestive of a disk herniation.

Dx:

1. Patient **history**
2. **Roots tests** (stand on heels, tiptoes, jerk tests)
3. Perform Straight Leg Raise Test **(SLR)**: Patient lies in a supine position. Then, his leg is lifted in a straight manner. When the leg is lifted straight up and the patient complains of pain, then tension happens to the muscles and stretches the Sciatic N. L4-L3.
4. **MRI**:

- MOST ESSENTIAL TEST
- CONFIRMATORY TEST

Spinal cord anatomy:

- Anterior median **fissure** ➔wide groove.
- Posterior median **sulcus** ➔ narrow groove
  Fissures are deeper than sulcus.
- **Central Canal**:
  1. Cavity of the spinal cord
  2. Continues with the 4th ventricle
  3. Lined by ependymal cells
  4. In it circulates the CSF.
- Gray matter ➔
  butterfly shape with a **gray commissure** and divided into HORNS
  1. Anterior horn (Ventral) ➔ Motor
  2. Lateral Horn ➔ autonomic
  3. Posterior (dorsal) ➔ sensory
- White matter➔ divided into Columns
  1. Anterio-lateral white column
  2. Posterior white column

  Also can be divided into tracts:
  1. Ascending tracts ➔ sensory

A. Posterior column divided into:

I. Gracile fasciculus. Gracile; Slight or slender نحيل, delicate, thin. Fasciculus; a bundle or collection of fibers all with the same orientation.

II. Cuneate fasciculus. Cuneate; wedge shaped " same as cuneiform"

B. Posterior spinocerebellar tract "spinal cord to cerebellum"

C. Anterior spinocerebellar

D. Anterior spinothalamic tract "spinal cord to thalamus"

E. Lateral spinothalamic tract

2. Descending tracts ➔motor

A. Rubrospinal "from red nucleus to spinal cord"

B. Reticulospinal "from reticular formation to spinal cord"

Types of sensory receptors:

Few Points

1. As the diameter increases the conducting velocity increases.

- A Alpha ➔ Fastest and thickest ➔ HIGH VELOCITY
- A beta ➔ slower, found in slow adapting mechanoreceptors.
- A Delta ➔ slower than beta
- C fibers ➔ slowest (unmyelinated; least diameter)

2. These receptors exist on the 1st order neurons fibers "nerve fiber = axon"
3. Receptor Adaptation ➔

** Rapid Adapting Receptors➔ signals fade away after stimulus exposure, BEST at detecting **rapidly ***CHANGING*** signals.**

** Slow Adapting Receptors ➔ signals is transmitted as long as the stimulus is present. Best at detecting a **long continuous signal.**

<table>
<tr><th>Receptor Type</th><th>Properties</th></tr>
<tr><td>1. Mechanoreceptors</td><td>- Responsible for proprioception, touch, stretch, and vibration.
4 Subtypes

<table>
<tr><td>Meissener's Corpuscle/ Tactile corpuscle</td><td>- Respond to touch, pressure & low frequency vibration (low frequency- 50 Hz)
- Encapsulated (outer capsule from the perineurium)</td><td>RAPID ADAPTING</td></tr>
<tr><td>Merkel's disc/ Tactile disc</td><td>Discriminative touch</td><td>Slow adapting</td></tr>
<tr><td>End organ of Ruffini</td><td>Sensitive to skin stretch</td><td>Slow adapting</td></tr>
<tr><td>Pacinian Corpuscle</td><td>- Vibrations (high frequency- 200Hz)
- Exist in deep layers (deep in reticular dermis)
- Encapsulated</td><td>Slow adapting</td></tr>
</table>
</td></tr>
<tr><td>2. Thermoreceptors</td><td>- Free nerve ending
- Detect change in temperature (cold or warm)
- TRP Channels (Transient receptor potential channels, give wide range of response)</td></tr>
<tr><td>3. Nociceptors</td><td>- Noci➔ damage/ pain
- Free nerve ending
- Detect Damage (Pain Receptors)
- Multimodal:
There's no type for sensory energy called pain. It is activated when we have an extreme signal from a stimulus. So, when, for example, heat stimulus reaches a higher degree at a certain point above its threshold "40-45 degrees; painful hot"</td></tr>
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Receptive Field:

- Every receptor receives sensation from a certain area of the skin, (**receptive field**)
- The greater the density of receptors, the smaller the receptive fields of individual afferent fibers ➔ the greater the accuracy ➔ higher acuity of discriminative touch
- Receptive field: Hand < elbow < shoulders (larger receptive field)
- The presentation of the hand in the higher center (the primary somatosensory cortex located in the parietal lobe “post central gyrus”) is larger than the back because of the huge number of receptors in the hand (smaller receptive fields).

Labelled line Theory:

- **Function** of receptors: change a certain type of energy to an action potential.
- Individual receptors preferentially transduce information about an **adequate stimulus.**
  **** Adequate stimulus** ➔ amount and type of energy required to stimulate a specific sensory organ.
- Individual primary afferent fibers carry information from a single type of receptor.
  • Conclusion:

➔ pathways carrying sensory information centrally are therefore also specific, forming a "labelled line" regarding a particular stimulus.

- Sensation:
  1. Modality ➔ Each neuron has 1 type of receptors ➔ can sense 1 type of stimuli.
  2. Locality ➔ The direction and destination in upper centers is well-localized. Each part of the cortex is responsible for a certain type of sensation.
  3. Intensity ➔ decided by frequency of action potential and how many receptors are activated.